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RADIUM

EDITED BY
CHARLES H. VIOL, Ph. D.
AND
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VOL. XIV OCTOBER, 1919 No. 1

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A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES

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RADIUM

A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY, PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES

Edited and Published by Charles H. Viol, Ph. D., and William H. Cameron, M. D. with the assistance of collaborators working in the fields of Radiochemistry, Radioactivity and Radiumtherapy.

Subscription $2.50 per year, or 25 cents per copy in the United States and Canada in all other countries $3.75 per year.

Address all communications to the Editors, Forbes and Meyran Avenues, Pittsburgh, Pa.

VOL. XIV OCTOBER, 1919 No. 1

DESCRIPTION OF AN APPARATUS FOR THE COLLECTION, PURIFICATION AND TUBING OF RADIUM EMANATION FROM A RADIUM SOLUTION.

By

CHARLES H. VIOL, Ph. D.

The use of radium on a very large scale for therapeutic treatments involves danger of loss, and this factor has been an important one in causing those hospitals and clinics with a gram or more of radium in use, to utilize radium emanation instead of using applicators containing radium.

Radium emanation was discovered in 1900 by Dorn, the name emanation having been suggested several years previously by Rutherford, for the analogous radioactive gas which was emitted from thorium compounds. Radium emanation is a radio-active gas, and decays with a half period of 3.85 days: that is, in 3.85 days half of any amount of radium emanation will have decayed or transmuted, and in another 3.85 days, half of the remaining emanation will decay and so on, so that by the end of 30 days, practically all of the emanation is gone. (See table II showing rate of decay of radium emanation).

Due to the fact that radium and radium emanation both are the source of the same decay products, namely Radium A, Radium B and Radium C, and that the beta and gamma rays utilized therapeutically result from the decay of the products Radium B and Radium C, it follows that either radium or the radium emanation may be employed. Radium, being a very slow decaying radio-element with a half decay

period of 1700 years, maintains practically constant amounts of Radium B and Radium C, resulting in a constant radio-activity, the emanation however, because of its rapid decay, has a constantly decreasing radio-activity.

The quantity of emanation in equilibrium with one gram of radium (element) has been named the "curie" in honor of Professor and Madame Curie. A curie of emanation has therefore the same beta and gamma ray activity as a gram of radium in equilibrium with its decay products, Ra Em, Ra A, Ra B and Ra C. A curie of emanation has a volume under normal conditions of temperature and pressure (O°C and 760 mm. barometric pressure) of 0.63 cubic millimeters, and weighs 6.2 micrograms (0.0000062 gram). Corresponding to micro- and milligrams of radium (mcgm. and mgm.) we have the terms micro- and millicuries (mcc. and mc.)

Radium emanation may be condensed by the use of liquid air, and by proper manipulation can by this means be secured in pure form.

Radium emanation has been collected, purified and used in applicators in place of the actual radium salt at the London Radium Institute since its inception in 1912. Stevenson of Dublin seems to be the first one (Brit. Med. Jour., July 4, 1914) who used the emanation in needles buried in a growth.

At present radium emanation is being utilized in all the hospitals and clinics where more than a gram of radium is being employed. In addition to the London Radium Institute there may be mentioned the Manchester (Eng.) and District Radium Institute; the Harvard Cancer Commission (Huntington Hospital, Boston); the Memorial Hospital, New York; the Howard A. Kelly Hospital, Baltimore; the Mayo Clinic, Rochester, Minn.; and the Radium Institute, Chicago.

There has been recently installed in the Radium Research Laboratory of the Standard Chemical Company of Pittsburgh, by Dr. G. Failla, physicist of the Radium Department at the Memorial Hospital, New York, an apparatus for the collection, purification and tubing of radium emanation obtained from a solution of a radium salt. See Fig. 1. This apparatus represents the latest type and is based on the Debierne-Duane apparatus* which differs from the earlier apparatus in that the liquid air is replaced by chemical means of purifying the radium emanation. In the apparatus installed at Pittsburgh, Dr. Failla has embodied all of the improvements which his experience at the Memorial Hospital has suggested, and the apparatus differs only in these details from the apparatus in daily use at that Hospital in the collection of the emanation derived from over three grams of radium.

It is obvious that this apparatus is quite fragile, and the operations in purifying, tubing and measuring the radium emanation are complicated, requiring the attention of a skilled operator, who best should be a thoroughly trained physicist.

In practice it is to be recommended that the glass parts be installed in duplicate, the additional parts being mounted on the opposite side of the steel frame. This avoids undesirable delays in securing the emanation in the event of accidental breakages or when it becomes necessary to replace the tubes in which the chemical purification of the emanation takes place. By reference to diagramatic Fig II, showing the apparatus, the method of securing the emanation may be briefly outlined.

*William Duane, Ph. D. Methods of Preparing and Using Radioactive Substances in the Treatment of Malignant Disease, and of Estimating Suitable Dosages. Boston Medical and Surgical Journal, CLXXVII, 787-799, Dec. 6, 1917. Reprinted in RADIUM, X, 93-112, March, 1918.

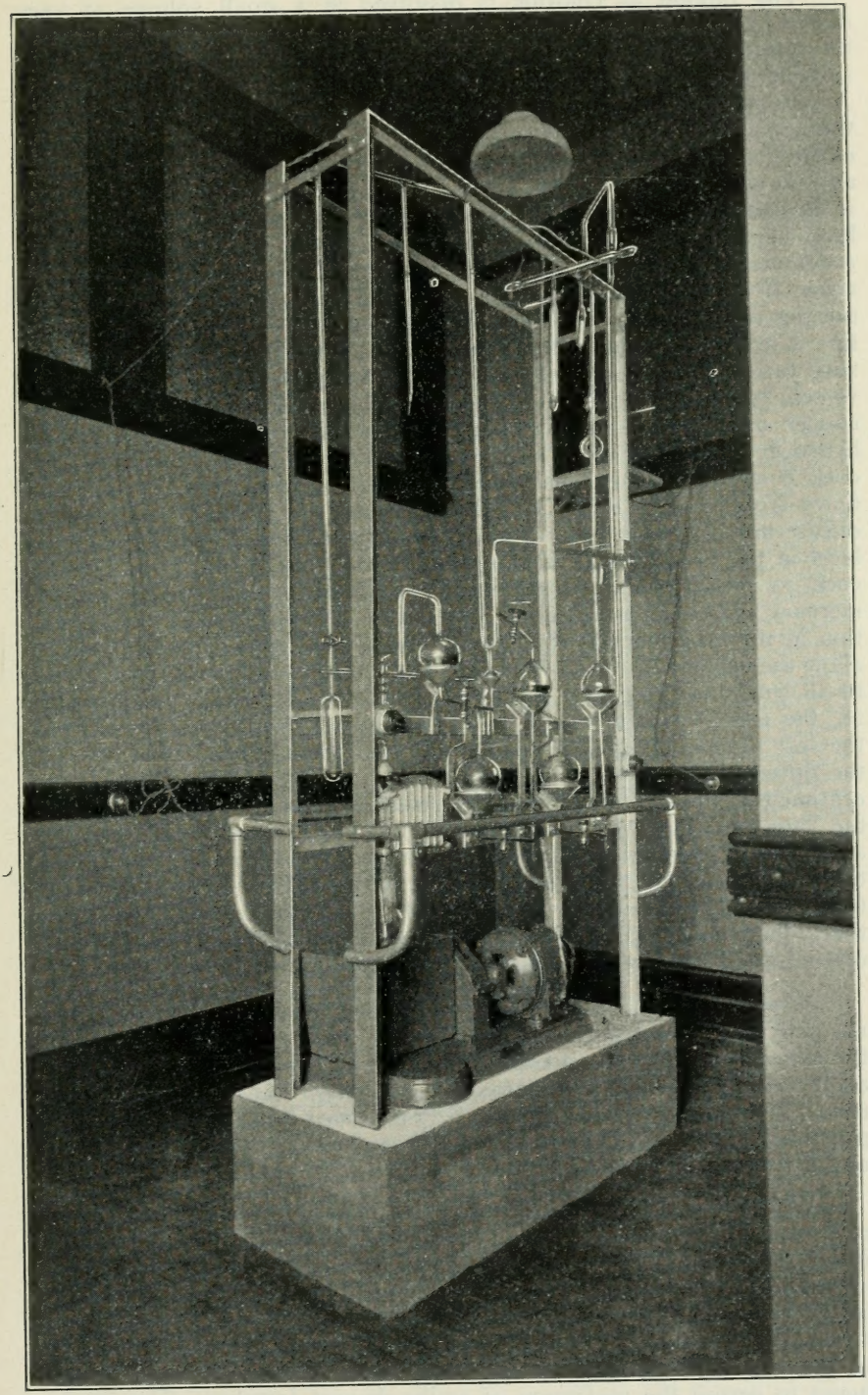
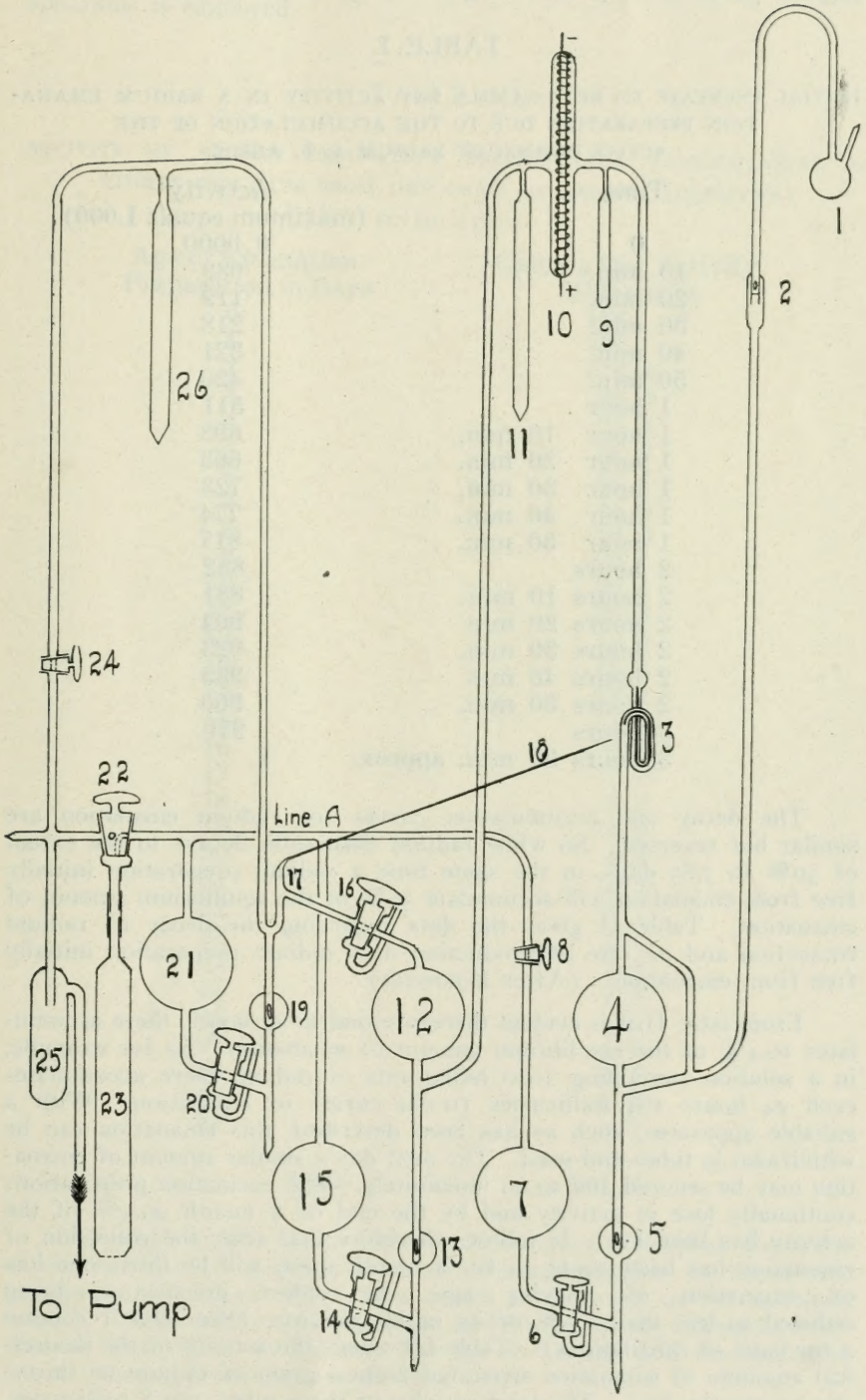


FIGURE I.

The radium as chloride is dissolved in a small volume of very dilute hydrochloric acid which prevents precipitation of the radium, the solution being placed in vessel 1. This vessel is usually placed in a suitable safe to guard against any possibility of loss of the radium. A suitable outlet tube leads from vessel 1 to connect it with the rest of the apparatus. When the apparatus is in working order, accumulated emanation is collected, etc., as follows: With the vacuum pump running and the stop cocks 22 and 8 set to give a vacuum in the line A, cock 6 is opened, allowing the mercury to pass from vessel 4 to 7, the mercury level being maintained just above 5, by closing 6. This permits the accumulated emanation, water, vapor, hydrogen, oxygen, etc., which come from the radium solution to largely diffuse into vessel 4. By turning stop cock 22 air is admitted through the drying tube 23 to the line A communicating with vessel 7, and on opening cock 6, air pressure raises the mercury into vessel 4, forcing the emanation over into vessels 9, 10 and 11 when the sodium hydroxide, the heated copper-copper oxide spiral and phosphorus pentoxide absorb carbon dioxide, hydrogen, moisture, etc. Vacuum is again established in line A, stop cock 8 and 6 having been closed, and on opening cock 14, mercury flows from vessel 12 into 15. This permits the purified emanation to diffuse into vessel 12. Air is again admitted to line A and the mercury level in the U shaped 17 is raised above the base of the U by opening cock 20, which is then closed again. Cock 14 is then opened and the mercury passes from vessel 15 into vessel 12, compressing the emanation in the tube at cock 16. This cock is then opened momentarily to allow the emanation to pass through. The whole operation is repeated until all emanation has been forced past cock 16. By again opening cock 20, the mercury from vessel 21 forces the purified emanation up into the left branch of 17 and thence out into the capillary tube 18. As the difference in level of the mercury in 21 and in 18 is only a few centimeters, the emanation is under reduced pressure, and upon heating the capillary tube with a fine flame, the glass softens, falls together and the tiny emanation tube can be drawn off without loss of emanation. The next day the same procedure is repeated to secure the emanation, which has meanwhile accumulated. The capillary tube containing the radium emanation under reduced pressure can be divided into the desired number of smaller tubes by the careful use of a tiny flame.

When just prepared, the emanation tubes have little beta or gamma ray activity. As the decay products Ra A, Ra B and Ra C are formed, the beta and gamma ray activity increases, until a maximum is reached about three and a half hours after the emanation has been placed in the tube. See table I. After this the beta-gamma ray activity decreases at practically the same rate at which the emanation is decaying, half of any activity being lost in 3.85 days.

Where it is desired to use the active deposit for application of the rays or for injection of a radioactive solution, the emanation is passed into a special glass vessel which is sealed on to the apparatus at 17. For an applicator the lead or metal plate which is to be activated is so exposed in the vessel as to permit the active deposit to form on the desired surface. When a solution is to be prepared, finely powdered salt is placed in the vessel. Emanation is admitted to the vessel for three to four hours to permit the maximum of active deposit forming. The emanation is then removed from the vessel by suitable manipulation, and the glass vessel is removed. The solution of active deposit is prepared by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Line A
To Pump

FIGURE II.

dissolving the salt in pure water. The activity of the active deposit may be determined by suitable gamma ray measurements.

TABLE I.

INITIAL INCREASE IN BETA-GAMMA RAY ACTIVITY IN A RADIUM EMANATION PREPARATION DUE TO THE ACCUMULATION OF THE ACTIVE DEPOSIT OF RADIUM A, B, AND C.

Time	Activity (maximum equals 1.000)
0	0.0000
10 min.	039
20 min.	119
30 min.	218
40 min.	321
50 min.	420
1 hour	511
1 hour 10 min.	593
1 hour 20 min.	663
1 hour 30 min.	723
1 hour 40 min.	774
1 hour 50 min.	817
2 hours	852
2 hours 10 min.	881
2 hours 20 min.	904
2 hours 30 min.	923
2 hours 40 min.	939
2 hours 50 min.	960
3 hours	970
3 hours 30 min. approx.	1.

The decay and accumulation curves for radium emanation are similar but reversed. So while radium emanation decays to the extent of 50% in 3.85 days, in the same time a radium preparation initially free from emanation will accumulate 50% of the equilibrium amount of emanation. Table II gives the data regarding the decay of radium emanation and its rate of production in a radium preparation initially free from emanation. (After Kolowrat).

From table II it is evident therefore that in 24 hours, there accumulates 16.4% of the equilibrium amount of emanation. So for example, in a solution containing 1000 milligrams of radium there accumulates each 24 hours 164 millicuries (0.164 curie) of emanation. With a suitable apparatus, such as has been described, this emanation can be withdrawn in tubes and used. The next day a similar amount of emanation may be secured and so on indefinitely. The emanation preparations continually lose in activity and by the end of a month 99.5% of the activity has been lost. It follows therefore that after the collection of emanation has been going on for a month there will be thirty-one lots of emanation of varying age, the oldest preparation being reduced to less than 0.5% of its initial activity. (See table I column 2 for basis of calculations). Table III shows the activity of the theoretical amounts of emanation separated from a gram of radium on thirty-one successive days. The total activity of these tubes, 991.8 millicuries, represents the same activity practically as the gram of radium which

produced the emanation. In practice an efficiency of 85 to 90% of the theoretical yield can confidently be expected when a properly designed apparatus is employed.

TABLE III.

ACTIVITY OF RADIUM EMANATION PREPARATIONS ACCUMULATING IN THIRTY-ONE DAYS FROM ONE GRAM OF RADIUM (ELEMENT) IN SOLUTION

Age of Emanation Preparation in Days	Gamma Ray Activity Milli-curies
0	164.
1	137.
2	114.4
3	95.5
4	79.8
5	66.7
6	55.7
7	46.5
8	38.9
9	32.5
10	27.1
11	22.6
12	18.9
13	15.8
14	13.2
15	11.0
16	9.2
17	7.7
18	6.4
19	5.4
20	4.5
21	3.7
22	3.1
23	2.6
24	2.2
25	1.8
26	1.5
27	1.3
28	1.1
29	0.9
30	0.7
Total	991.8

The scope of this paper does not contemplate a detailed discussion of the methods of application of the emanation tubes in therapeutic treatments. For these details the reader is referred to the excellent work by Doctors Janeway, Barringer and Failla, of the Memorial Hospital of New York, on Radium Therapy in Cancer, and the article by Doctor Duane, previously mentioned.

TABLE II.

Decay and Growth of Radium Emanation

A=fraction of emanation remaining after time t.

B=fraction of equilibrium amount of emanation formed in t days in a radium preparation initially free from emanation.

Time				Time			
days	hours	A	B	days	hours	A	B
	0	1.00000	0.00000	1	22	70822	29178
	1	0.99253	0.00747	1	23	70293	29707
	2	98511	01489	2	0	69768	30232
	3	97775	02225	2	1	69246	30754
	4	97045	02955	2	2	68729	31271
	5	96319	03681	2	3	68215	31785
	6	95600	04400	2	4	67706	32p94
	7	94885	05115	2	6	66698	33302
	8	94176	05824	2	8	65705	34295
	9	93473	06527	2	10	64726	35274
	10	92774	07226	2	12	63763	36237
	11	92081	07919	2	14	62813	37187
	12	91393	08607	2	16	61878	38122
	13	90710	09290	2	18	60957	39043
	14	90032	09968	2	20	60050	39950
	15	89360	10640	2	22	59156	40844
	16	88692	11308	3	0	58275	41725
	17	88029	11971	3	3	56978	43022
	18	87372	12628	3	6	55711	44289
	19	86719	13281	3	9	54471	45529
	20	86071	13929	3	12	53259	46741
	21	85428	14572	3	15	52074	47926
	22	84789	15211	3	18	50916	49084
	23	84156	15844	3	21	49783	50217
1	0	83527	16473	4	0	48675	51325
1	1	82903	17097	4	3	47592	52408
1	2	82283	17717	4	6	46533	53467
1	3	81669	18331	4	9	45498	54502
1	4	81058	18942	4	12	44486	55514
1	5	80453	19547	4	15	43496	56504
1	6	79852	20148	4	18	42528	57472
1	7	79255	20745	4	21	41582	58418
1	8	78663	21337	5	0	40657	59343
1	9	78075	21925	5	4	39455	60545
1	10	77492	22508	5	8	38289	61711
1	11	76913	23087	5	12	37158	62842
1	12	76338	23662	6	16	36059	63941
1	13	75768	24232	5	20	34994	65006
1	14	75201	24799	6	0	33960	66040
1	15	74639	25361	6	4	32956	67044
1	16	74082	25918	6	8	31982	68018
1	17	73528	26472	6	12	31037	68963
1	18	72979	27021	6	16	30119	69881
1	19	72434	27566	6	20	29229	70771
1	20	71892	28108	7	0	28365	71635
1	21	71355	28645	7	4	27527	72473

Time				Time			
days	hours	A	B	days	hours	A	B
7	8	26714	73286	15	0	06721	93279
7	12	25924	74076	15	8	06329	93671
7	16	25158	74842	15	16	05961	94039
7	20	24414	75586	16	0	05613	94387
8	0	23693	76307	16	8	05287	94713
8	4	22993	77007	16	16	04979	95021
8	8	22313	77687	17	0	04689	95311
8	12	21654	78346	17	8	04416	95584
8	16	21014	78986	17	16	04159	95841
8	20	20393	79607	18	0	03916	96084
9	0	19790	80210	18	12	03579	96421
9	4	19205	80795	19	0	03271	96729
9	8	18637	81363	19	12	02990	97010
9	12	18087	81913	20	0	02732	97268
9	18	17291	82709	20	12	02497	97503
10	0	16530	83470	21	0	02282	97718
10	6	15803	84197	21	12	02086	97914
10	12	15107	84893	22	0	01906	98094
10	18	14442	85558	22	12	01742	98258
11	0	13807	86193	23	0	01592	98408
11	6	13199	86801	23	12	01455	98545
11	12	12619	87381	24	0	01330	98670
11	18	12063	87937	24	12	01216	98784
12	0	11533	88467	25	0	01111	98889
12	6	11025	88975	25	12	01015	98985
12	12	10540	89460	26	0	00928	99072
12	18	10076	89924	27	0	00775	99225
13	0	09633	90367	28	0	00647	99353
13	8	09072	90928	29	0	00541	99459
13	16	08543	91457	30	0	00452	99548
14	0	08046	91954	40	0	00074	99926
14	8	07577	92423	50	0	00012	99988
14	16	07136	92864				

THE USE OF HEAT AND RADIUM IN THE TREATMENT OF CANCER OF THE JAWS AND CHEEKS*

G. B. NEW, M. D.

Cancer of the jaws and cheeks is one of the most malignant forms of new growth. The type that is primary in the cheek is probably exceeded in its malignancy only by the melano-epithelioma. Little is known regarding the causation of such growths except that chronic irritation of some sort is believed to be an important factor, and this being true, every snag of tooth or any other source of irritation should be eliminated from the mouth as a prophylactic measure. While tobacco may be a cause in some cases, it probably has not so much im-

*Reprinted from the Journal of the American Medical Association, LXXI, 1369-70, 1918. Presented before the Section of Stomatology at the 69th Annual Session of the American Medical Association, Chicago, June, 1918.

portance as it usually attributed to it. The man with cancer of the cheek who chews tobacco has, as a rule, carried the tobacco on the unaffected side of the mouth. Syphilis is undoubtedly a factor in the production of cancer of the tongue, but is of no demonstrable consequence in relation to cancer of the jaw and cheek. Papillary leukoplakia frequently develops into epithelioma, and it should be thoroughly treated with cautery and radium.

Fifty-seven cases of cancer of the jaws and cheeks were examined at the Mayo Clinic during 1917. Thirty-two of the patients were inoperable; 4 had glandular involvement, but operation was considered advisable and a block dissection was done in addition to the treatment of the local growth. Twenty-one had no glandular involvement and were treated with the cautery and radium. Data concerning these 21 patients form the basis of this paper. In most instances epitheliomas occurred in the fifth decade. There were two patients between thirty-one and forty years of age; 4 between forty-one and fifty; 12 between fifty-one and sixty, and 3 between sixty-one and seventy. Nineteen were men and two were women. The patients had first noticed the trouble from two weeks to four years before they came for examination, but it was difficult to determine the length of time the growth had been present or active. The tumor was located on the lower jaw in 2 cases, on the lower jaw and cheek in 7, on the upper jaw in 2, on the upper jaw and cheek in 7, and on the cheek in 3. Five of the 21 patients had been operated on before coming to the clinic. Seven of the epitheliomas were associated with, and apparently had originated in, a leukoplakia. In one case the tumor developed on a pathologic fracture of a bone cyst of the jaw.

Treatment. In reviewing the literature it is seen that the usual method employed in the treatment of cancer of the jaws and cheeks has been a complete or partial resection of the jaw with some type of plastic operation if the growth involved the cheek. Recently the cautery has been used in the treatment, but I have been unable to find any report in the literature of a group of cases treated in this manner. At the Mayo Clinic the cautery has been employed for several years in the treatment of such cancers, with a few exceptions, in preference to resection of the jaws. In many instances the radium has been used following the cautery.

During the year 1917 all the patients operated on were treated by the slow heat cautery with soldering irons, and, in addition, radium was used. While a report of recently treated cases of cancer must necessarily be only preliminary, nevertheless the results have been very encouraging, and I feel that we have obtained better immediate results than were obtained previously in the treatment of cases of this type.

In cases of cancer of the jaw or cheek without glandular involvement the decision as to whether or not they are surgical depends on individual judgment, but in any questionable cases the patient should be given the chance an operation may afford, and everything possible should be done for him.

Before operation patients are advised that they must return for observation at least once a month during a period of six months or more following operation, so that they may have immediate care if there is any recurrence. When the seriousness of the condition and the neces-

sity for co-operation are explained, it is usually not difficult to get patients to return at stated intervals.

TECHNIC. After the patient is anesthetized with ether a mouth-gag is inserted opposite the affected side. The tongue is drawn to one side out of the way by the aid of a stomach clicker. The water-cooled speculum is inserted, and all the teeth in the area involved, or those that prevent good exposure of the growth, are removed. If it is possible, the entire growth is excised from the jaw or cheek with a knife cautery, and the base is cauterized with soldering irons. If this is not possible, the irons are inserted into the tumor. The water-cooled speculum prevents the burning of the lips or cheeks except in the area being treated, and it affords good exposure. A wooden tongue depressor holds the tongue out of the way and prevents it from being burned. The cautery should be used longer than seems really necessary—at least for from twenty to forty-five minutes. If the growth is in the upper jaw and involves the antrum, the soldering irons are carried up into the antrum and the entire growth is gradually burned away.

Soldering irons are found to be the most satisfactory type of cautery, as the heating element in the handle of the electric cautery usually interferes with a good view of the area that is being treated. If the irons are too hot, the surface cauterized becomes carbonized and prevents the penetration of the heat. A slow heat that gradually cooks the tumor is preferable. Occasionally hemorrhage will occur during the first ten days or two weeks following the cauterization while the slough is clearing off, and if it is not readily controlled by packing, ligation of the external carotid with the lingual and facial branches is advisable.

About two weeks after the cauterization most of the slough will have cleared off, and radium may be applied directly into this open area. It is directed into the ulcerating area on lead applicators, using a 50 or 100 mg. tube within a silver tube, for from fifteen to twenty hours, without screening. If the growth has involved the cheek radium is applied with screening externally over the cheek, thus cross-firing. If the growth has involved the antrum, the radium is placed in the antrum, packed there with petrolatum gauze, and left in place for the period of hours required by the particular type of lesion.

In from a month to six weeks after the operation, large pieces of sequestrum usually come away from the jaw. These pieces are sometimes one-fourteenth to three-eights inch thick. In a month from the first radium treatment is completed further treatment is given and repeated as often as the condition indicates. If there is any recurrence noted, a second cauterization is done, and this is followed by radium.

Epithelioma of the jaw does not, as a rule, metastasize early, unless there is considerable involvement of the cheek. In such a case the submental and submaxillary glands on the affected side should be removed.

RESULTS. Of the 21 patients treated, 20 were traced; of these, 14 have been free of local recurrence for from six to eighteen months. One patient recauterized three months previously, thus far has no recurrence.

One died of lymphatic leukemia six months after operation; there was no recurrence. Two of the 14 patients (one with epithelioma of the cheek and one with epithelioma of the upper jaw and cheek) have developed glands of the neck and have had block dissections. Thus 12 of the 20 patients have had no recurrence locally or in the glands for from six to eighteen months. One patient has a hopeless local recur-

rence. This patient was operated on before coming to the clinic. Two patients died of the cancer; one of these had been operated on before coming to the clinic; one consulted a plaster doctor, and his present condition cannot be learned from his letter. There was no operative mortality.

This group of cases shows that our immediate results in the treatment of epithelioma of the jaws and cheeks without glandular involvement, by the use of the cautery and radium, have been very encouraging. The end-results cannot be foreseen, but we believe that by the addition of radium to the treatment much more is being accomplished than formerly.

THE VALUE OF RADIUM IN THE TREATMENT OF NEOPLASMS OF THE NOSE, THROAT AND MOUTH

G. B. New, M. D.

It is now generally accepted, by those familiar with its use, that radium holds a distinctive place in the treatment of neoplasms. In no class of cases is it of greater value than in the types seen by the otolaryngologist. This is particularly encouraging because of the fact that the results following the surgical treatment of many of these neoplasms have not been satisfactory. The special value of radium in such cases is that it may be carried directly into the antrum nasopharynx or larynx, and thus come in direct contact with the neoplasm.

Radium has a specific or alterative action on certain tissues, such as basal-cell epithelioma, sarcoma, angioma, etc., causing the tumors gradually to shrink up and disappear. Its action on other types of tissue, for example, the squamous cell epithelioma, is destructive. The more rapidly growing tumors, such as lymphosarcomas are made to disappear much more readily by the use of radium than are the slow-growing tumors, such as mixed tumors of the parotid or slow-growing fibromas of the nose.

Methods of Application. The radium is applied in the form of a plaque or disc, over the surface of which it is spread out and held in place by a varnish; or it is applied in a glass tube inside of a silver tube about one-sixteenth by one-half of an inch in size. The disc form of application is used with little or no screening, in superficial lesions, or it is screened and applied to penetrate, as in the treatment of glands of the neck. The tubes are used with screening in applications over the tumor, or they are inserted directly into the tumor. The size of the tube usually employed contains from fifty to one hundred mg. of radium element. The radium emanation has not been used in any of our work.

In the treating the nasopharynx the tube is placed in a curved lead applicator and the radium is dropped directly into the region requiring it. In some cases, especially of multiple papillomas of the larynx in children, the radium is inserted directly into the larynx on a forceps and left in place while the patient, under anesthesia, is suspended by the Lynch suspension apparatus. Neoplasms of the antrum are treated by

*Reprinted from the Canadian Medical Week, 1918. Presented before the Ontario Medical Association, Hamilton, Ont., May, 1918.

making an opening directly into the antrum above the alveolar process by means of a soldering iron, and then the radium, with no screening but the silver tube and a rubber finger-cot, is inserted directly into the center of the tumor. In treating the antrum and larynx, radium is also applied with screening outside of the cheek or larynx and elevated about an inch from the skin to avoid any superficial reaction. In angiomas or lymphangiomas of the lips, cheeks and tongue the radium is inserted directly into the tumor by burrowing into it through the normal tissue. In lip and cheek it is inserted from the inside of the mouth, and thus any external scarring is avoided. Frequently special applicators have to be made in order to apply the radium to some particular area.

TYPES OF CASES TREATED. Radium is used in many of our cases post-operatively. In fact in all cases of malignancy of the nose, throat and mouth in which the patients are treated surgically they are also treated with radium following the operation. In inoperable cases the possibility of relief from treatment with radium is explained to patients, so they may thoroughly realize that nothing surgical will help, and that just what the radium will do is questionable, although months or even years of relief may be obtained, and possibly the condition may be cured.

In case suitable for surgical treatment radium alone is not used, as we feel that if the condition is surgical, the patient should be given the benefit of both methods of treatment. Radium should never be employed in lesions such as those of the lower lip, for example, unless they have been diagnosed microscopically. The safer procedure is to excise the lesion for diagnosis, and if it is malignant, the glands of the neck draining the area should be removed in order to prevent metastasis. Many mistakes are made by removing with radium or some treatment other than excision a lesion of the lip which is malignant, the patient later developing metastasis in the neck with the possibility of cure reduced about 50 per cent.

During the last two years at the Mayo Clinic 211 neoplasms of the nose, throat and mouth have been treated with radium. These cases are exclusive of the cases of basal lesions of the nose, face, etc. While it is too soon to report end results in this group I shall, in general way, outline the results to the present time:

1.—Nose (Intranasal)

Epithelioma	9
Papilloma	3
Myxoma	3
Sarcoma	1
Total	16

2.—Nasopharynx.

Epithelioma	5
Myxoma	3
Fibromyxoma	1
Fibrosarcoma	1
Lymphosarcoma	3
Malignant Tumor	1
Total	14

3.—Antrum.

Epithelioma	9
Sarcoma	4
Myxoma	1
Fibroma	1
Total	15

4.—Pharynx and Tonsil.

Epithelioma	6
Sarcoma	4
Total	10

5.—Larynx.

Epithelioma	21
Multiple papilloma	13
Angioma	2
Amyloid	3
Lupus (pharynx and larynx)	2
Total	41

6.—Jaws and Cheeks (Intra-oral)

Epithelioma	47
Sarcoma	3
Lymphangioma	2
Adamantinoma	3
Total	55

7.—Palate.

Epithelioma	7

8.—Tongue.

Epithelioma	13
Lymphangioma and Angioma	10
Lymphosarcoma	1
Total	24

9.—Upper Lip.

Angioma	11
Basal cell epithelioma	8
Lymphedema	8
Total	27

10.—Lower Lip.

Angioma	2

TUMORS OF THE NOSE. Angiomas of the external nose are readily taken care of by radium, and the results are far superior to those obtained with the use of hot water injection or CO_2 (carbon dioxid) snow. In the basal cell epithelioma of the nose formerly was excised with a cautery, especially if the cartilage was involved. Later if the condition was cured, a plastic operation was necessary to close the opening of the nose. Such growths are now cleared up with radium with the smallest amount of deformity, if any.

INTRANASAL AND NASOPHARYNGEAL TUMORS. Sarcoma, myxoma and fibroma are best treated with radium. The operative treatment of such tumors usually involves considerable risk, because of the liability to hemorrhage, and in most cases the tumor recurs. By the use of radium the patient is usually markedly benefited, receiving months or years of relief, if indeed the condition is not entirely cleared up. In the treatment of such tumors, other than the fibroma or fibrosarcoma, it is best to apply the radium to the cervical regions also in order to prevent glandular involvement.

Operative measures in the treatment of epithelioma of the nose are usually of little value. Radium frequently clears up the ulceration and discharge and scars down the growth, giving the patient much relief, and sometimes accomplishing more than this. Myxomas of the nostril, which are not associated with the sinus infection and which always recur after removal surgically, are caused to disappear by the use of radium.

TUMORS OF THE ANTRUM. In case of malignancy of the antrum, unless of the type of fibroma or fibrosarcoma that shells out readily, the condition is treated almost exclusively by making an opening into the antrum above the alveolar process by means of a soldering iron and inserting radium. In one group of cases, especially if the cheek is involved, treatment by resection of the upper jaw is not satisfactory. The method of cooking the tumor by means of soldering irons and slow heat for from one-half to three-fourths of an hour, followed by radium in the cavity, is to be preferred and gives much better results, notably in cases of sarcoma.

TUMORS OF THE PHARYNX AND TONSIL. Probably the most spectacular results are obtained in the treatment of a lymphosarcoma of the pharynx. A huge mass filling the pharynx will melt away and in three

or four days disappear without leaving a trace. In such cases, however, enlarged cervical glands frequently develop, and while these may be cleared up, the patients may die of chest metastasis, although they have received months or years of relief and comfort. Such conditions are hopeless surgically, and radium will accomplish a great deal.

With all the measures at our disposal, epitheliomas of the tonsil are very difficult to clear up, but we have one patient who has been free from recurrence for nearly two years following an extensive recurrence after excision and cautery. Other patients have been markedly relieved and improved, and we feel that the possibility of improvement and help warrants the use of large doses of radium, preferably after removal of the growth. If there is a good possibility of improvement in the local growth, a block dissection should be done and this followed by radium over the neck. Lupus of the pharynx is readily cleared up with radium; this seems to be the most satisfactory way of treating it.

Tumors of the Larynx. An extensive squamous-cell epithelioma of the larynx is usually considered a hopeless problem, since surgery offers very little in the way of relief. We have treated such cases by doing a tracheotomy, and after cocainization, dropping the radium directly into the larynx. The radium is held in place for from one to one and one-half hours at a time. While all patients are not benefited, very encouraging results and remarkable relief have been obtained. One man had an extensive carcinoma of the larynx obstructing the glottis so that it was necessary to do a tracheotomy; he was swallowing fluids only. In two months' time he had gained forty-eight pounds and could eat anything. He had a cork in the tracheotomy tube. The growth did not recur locally, but the patient died of chest metastases about fourteen months later. However, the treatment gave him a year of comfort. The local tumor does not always completely disappear, as in the foregoing case, but the patients that do improve make one feel that everything possible should be done to give them the benefit of radium.

Lupus of the larynx is treated by dropping the radium down into it after cocainizing. The results are very good.

One case of angioma of the larynx, causing dyspnea in a child which would have been very difficult to benefit in any other way, was entirely cleared up by the external application of radium.

The treatment of multiple papilloma of the larynx in children has been improved wonderfully by the addition of radium. The patient is suspended with the Lynch suspension apparatus, the papillomas are cleared out, and while thus suspended the radium is placed in the larynx in children without tracheotomy, the only treatment being radium on the outside of the neck. The tumors cleared up entirely and have not recurred.

Lips. Ulcer of the lip or epithelioma of the lip should not be treated with radium. Every suspicious lesion of the lip should be excised for diagnosis, aod if it is found malignant the submaxillary and submental glands should be removed. Many such lesions may readily be cleared up with radium, but it cannot be determined whether or not the lesion is malignant without a microscopic examination. Many patients come with metastasis in the neck when an epithelioma of the lip has been removed with radium or some other means, and no glandular dissection done.

Tumors of the Jaw and Cheek. In the treatment of malignancy of the jaw and cheek the growth, if surgical, is first thoroughly cau-

terized by slow heat cautery by means of a soldering iron. In about two weeks radium is applied directly into the raw area. The radium is applied again in from three to four weeks and as often as necessary later. The addition of radium to the treatment has made our immediate results much better than they have ever been before. Twenty-one cases of cancer of the jaws and cheeks were treated during the year 1917; 20 of the number have been traced; 14 of these have had no local recurrence. In 2 of the 14 cases glands of the neck have developed, and block dissections have been done. In one case of primary squamous-cell epithelioma of the cheek almost perforating, the tumor cleared up entirely, and there has been no recurrence for more than a year. This, of course, is an unusual result, but it is a stimulant to give the patient this chance of help in many inoperable cases.

Leukoplakia of the mucous membranes of the mouth is treated with radium and the condition cleared up.

TUMORS OF THE TONGUE. Cases of lymphangioma and angioma of the tongue are very difficult to deal with surgically and as a rule, very little is accomplished. Radium is a specific for these conditions, and very large tongues will become reduced almost to normal in a few weeks or months. Radium is either inserted directly into the tongue, or screened and applied over the tongue.

Radium is employed in epithelioma of the tongue, occasionally alone, if the condition is inoperable or if the patient's general condition will not permit operation. It is more frequently used post-operatively after excision of half the tongue and block dissection. The radium decreases the discharge, scars down the lesion and makes the patient much more comfortable.

I have not seen in the literature reports of the use of radium in thrush, out in our experience its repeated application has eliminated this very persistent trouble.

RESULTS. The immediate results of the treatment of the neoplasms of the nose, throat and mouth with radium are, as a whole, very encouraging. Many patients previously operated on with a recurrence following are now treated with radium and the neoplasm disappears, giving months or years of relief, with no surgical mortality. The patients are made much more comfortable than they would be with an operation. The number of patients that will be permanently cured of a true malignancy with radium is probably very small relatively, but the number of inoperable cases that are markedly relieved and receive months or years of comfort is quite large. We do not, however, recommend the treatment by radium of any neoplasm that is surgical. In such cases the patient should have the benefit of both surgery and radium. The use of radium has changed entirely the prognosis in neoplasms of the nose, throat and mouth.

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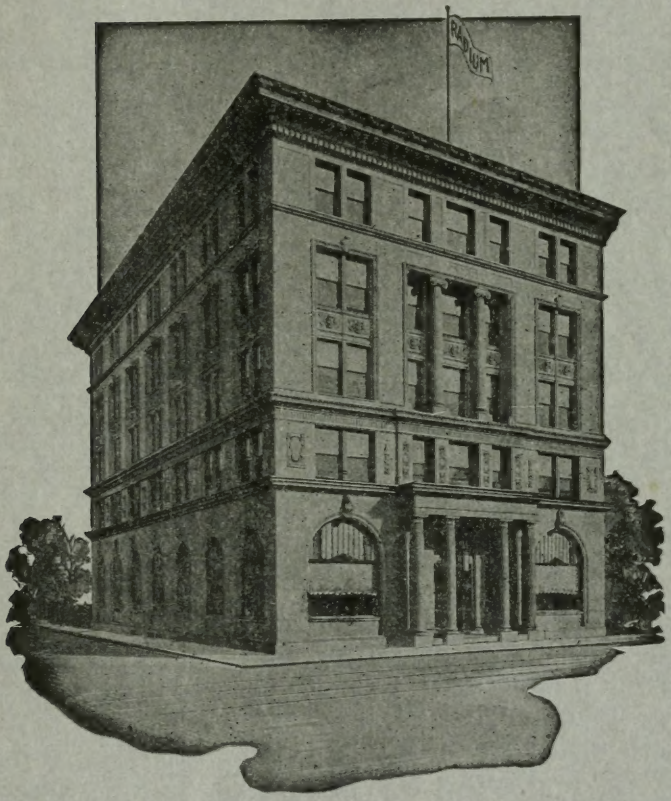

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